# FLEXIBLE DISPLAYS AS AN INPUT DEVICE

## FIELD OF THE INVENTION

[0001] The present invention relates to input and display devices for computer systems.

## BACKGROUND OF THE INVENTION

[0002] Mobile devices typically have limited space and small screens. They have room for only a few buttons. In order to provide a larger screen size, a device designer is often required to further limit the size or number of control elements simply because the smaller sizes that have permitted mobile devices to be mobile, also tend to restrict the amount of surface space that can be used for display or control. Advances in display technology have made it feasible to construct displays that can be flexed to conform to non-planar surfaces or folded to facilitate more compact storage. At present, OLED displays are being prototyped on flexible substrates by Universal Displays, University of Arizona Optical Sciences Center, Philips Research, Dupont, Army Research Labs, other members of the US Display Consortium, etc. It is envisioned that unrolling or unfolding flexible displays may reduce the requirement for small or light devices to necessarily have small displays, but device output is only one part of the user-interface problem. An additional concern relates to user input and control.

[0003] Previous efforts to address the problem of user input on compact devices have typically involved attaching larger devices to the compact device or projecting a virtual display onto a flat surface. Numerous companies (including Think Outside, Inc., of Santa Clara, Calif.) produce keyboards that can be attached to compact devices such as hand held computers and mobile phones in order to provide a large (comfortable) input mechanism. However, the size of such external input mechanisms can minimize the advantage provided by the size of the easily carried compact device. Other companies (including Virtual Devices, Inc., of Allison Park, Pa.) have taken the approach of projecting an interface onto a large flat surface and detecting user interaction with this projected interface. This latter approach potentially address the issue of device size, but adds a usage constraint, requiring the availability of a large flat surface.

[0004] One solution to the general problem of limited space for display and user input is to provide mechanisms for control on the display itself. Handheld devices (such as those manufactured by palmOne Inc. of Milpitas, Calif.) and tablet devices (such as those manufactured by Wacom Technology Corporation of Vancouver, Wash.) often employ this strategy by providing stylus control for directly interacting with displayed information. Another mode of direct manipulation has been suggested where action results from a user bending the display (as suggested by Sony Incorporated, based in Tokyo, Japan). However, the simple modes of direct manipulation mentioned above all have drawbacks. The single-sensor flexible display lacks the ability to detect the richness of the user interaction with the display because it is only capable of measuring one kind of bend. Similarly, touchscreen displays typically do not detect the richness of the user interaction (instead capturing only a location expressed in X and Y coordinates). Where a tablet and stylus is used in combination to achieve greater levels of control, the stylus becomes yet another component which can be misplaced or damaged. Thus, there is a desire for displays which are capable of accepting rich user input without having the drawbacks of existing devices.

## SUMMARY OF THE INVENTION

[0005] The invention broadly and generally provides a display comprising: (a) a flexible surface operable to exhibit images, the aforesaid flexible surface being capable of exhibiting variable degrees of bend; (b) a plurality of bend sensors for creating a plurality of bend measurements from a line of bend; and (c) a line detection device operable to detect orientation and position of the aforesaid line of bend based on the aforesaid plurality of bend measurements.

[0006] In an exemplary embodiment, at least one of the aforesaid bend sensors comprises a strain gauge such as a peizo-electric bimorph or a fiber-optic curvature sensors.

[0007] In an exemplary embodiment, the aforesaid bend sensors are layered on the display in various directions. In other exemplary embodiments, bend sensors may be distributed according to a pattern on the surface or along the edges of the aforesaid display.

[0008] In an exemplary embodiment, the display comprises a touch sensor operable to detect contact to the aforesaid flexible surface.

[0009] In an exemplary embodiment, the flexible surface comprises at least one organic light emitting diode. In other exemplary embodiments, the flexible surface comprises at least one liquid crystal display element.

[0010] In an exemplary embodiment, the aforesaid display comprises multiple flexible surfaces, each operable to exhibit images.

[0011] In an exemplary embodiment, the aforesaid display comprises a controller operable, when activated, to manipulate an element of the aforesaid image, the aforesaid line detecting device being operable to activate the aforesaid controller. In an exemplary embodiment, the aforesaid element of the aforesaid image comprises a scroll bar.

[0012] The invention further broadly and generally provides a method of controlling the information presented on a display, the aforesaid display comprising: (1) a flexible surface operable to exhibit images, the aforesaid flexible surface being capable of exhibiting variable degrees of bend; (2) a plurality of bend sensors for creating a plurality of bend measurements from a line of bend; and (3) a line detection device operable to detect orientation and position of the aforesaid line of bend based on the aforesaid plurality of bend measurements, the aforesaid method comprising the steps of: (a) obtaining the orientation and position of a line of bend present on the aforesaid flexible surface; and (b) making a change to the information displayed by the aforesaid display in response to the orientation and position of the aforesaid line of bend present on the aforesaid flexible surface.

[0013] In an exemplary embodiment, the aforesaid line of bend orientation and position are used to control at least one graphical user interface element, such as a scroll bar or a cursor.

[0014] In an exemplary embodiment, the aforesaid step of obtaining the orientation and position of a line of bend